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APPLICATION FOR U.S. LETTERS PATENT

Title:

SUTURE ANCHOR ATTACHED TO TISSUE-FIXATION DISK WITHOUT TOP KNOT

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SUTURE ANCHOR ATTACHED TO TISSUE-FIXATION DISK WITHOUT TOP KNOT

[0001] This application claims the benefit of U.S. Provisional Application Serial No. 60/405,706, filed August 26, 2002, the entire disclosure of which is incorporated by reference herein.

FIELD OF THE INVENTION

[0002] The present invention relates to suture anchors used for attachment of suture to bone, and more particularly, to a suture anchor equipped with a tissue fixation device but without a top knot.

BACKGROUND OF THE INVENTION

[0003] When soft tissue tears away from bone, reattachment becomes necessary. Various devices, including sutures alone, screws, staples, wedges, and plugs have been used to secure soft tissue to bone. Recently, various types of suture anchors have been developed for this purpose. For example, U.S. Patent No. 4,632,100 discloses a cylindrical suture anchor which includes a drill bit at a leading end for boring a hole in a bone. The drill bit at the leading end is followed by a flight of threads for securing the anchor into the hole bored in the bone by the drill bit. Another example is U.S. Patent No. 5,370,662 which discloses a self-tapping suture anchor having a flight of threads around a solid body. Similarly, U.S. Patent No. 5,156,616 discloses a suture anchor having an axial opening for holding a knotted piece of suture.

[0004] The devices disclosed in the above-cited patents anchor suture to bone, but require the surgeon to tie a knot in the suture arthroscopically in order to achieve fixation of the soft tissue to the bone. As a result, devices which do not require arthroscopic knot tying for fixation have been proposed. For example, U.S. Patent No. 6,027,523, the disclosure of which is incorporated by reference herein, describes a suture anchor equipped with a tissue-fixation disk which does not require arthroscopic knot tying for fixation. The free ends of suture of the suture anchor are secured to the tissue-fixation disk by using knots on the top of the tissue-fixation disk, as well as a drop of polyacrylamide or similar cement material to secure the knots to the tissue-fixation disk.

[0005] It would be desirable to provide a suture anchor with an attached tissue-fixation disk which does not require multiple suture knots that are exposed on the upper surface of the tissue-fixation disk.

SUMMARY OF THE INVENTION

[0006] The suture anchor of the present invention overcomes the disadvantages of the prior art and fulfills the needs noted above by providing a suture anchor attached to a tissue-fixation disk with a suture knot that resides in a recess in the suture anchor, rather than on the exposed surface of the tissue-fixation disk.

[0007] In the preferred embodiment of the present invention, the suture that connects the tissue-fixation disk to the suture anchor is a single strand which is looped through an eyelet or passage formed through the proximal end of the suture anchor and through the tissue-fixation disk. Advantageously, the free ends of the suture are tied in a knot within the eyelet of the suture anchor.

[0008] Other features and advantages of the present invention will become apparent from the following description of the invention which refers to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Figure 1 illustrates a perspective diagrammatic view of a suture anchor in accordance with a first embodiment of the present invention.

[0010] Figure 2 illustrates a three-dimensional view of the suture anchor of Figure 1.

[0011] Figure 3 illustrates a three-dimensional view of a suture anchor in accordance with a second embodiment of the present invention.

[0012] Figure 4 illustrates a schematic perspective view of the suture anchor of Figure 1 loaded on a driver of the present invention.

[0013] Figure 5 illustrates a schematic elevation of the suture anchor of Figure 1 which has been installed according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] The present invention provides a suture anchor attached to a tissue-fixation disk with a suture knot that resides in a recess in the suture anchor, rather than on the exposed surface of the tissue-fixation disk. In the following preferred embodiment of the invention, the suture that connects the tissue-fixation disk to the suture anchor is a single strand which is looped through an eyelet formed through the proximal end of the suture anchor and through the tissue-fixation disk. Advantageously, the free ends of the suture are tied in a knot within the eyelet formed through the proximal end of the suture anchor.

[0015] Referring now to the drawings, where like elements are designated by like reference numerals, Figures 1-3 illustrate exemplary embodiments of suture anchors 100, 200 manufactured according to the present invention. As explained in more detail below, the suture anchor of the present invention does not require knots on the upper surface of the tissue-fixation disk.

[0016] The suture anchor 100 of Figures 1-2 comprises an elongated body member 10 and a driving end or head 50 which is associated with a tissue-fixation device 70. As shown in Figure 1, the tissue-fixation device 70 is a disk. However, the invention also contemplates a tissue-fixation device of other geometric shapes and configurations, for example, a rod, a straight bar or a bended bar, among others. The elongated body member 10 has the shape of a tapered cylinder with a continuous thread 20 wrapping around the tapered cylinder in a clockwise direction. The elongated body member 10 is illustrated as having a particular configuration and geometry, that is, a corkscrew configuration such as the one disclosed and described in detail in U.S. Patent No. 6,214,031 to Schmieding et al., the disclosure of which is incorporated by reference herein.

[0017] Extending from the proximal end of the elongated body member 10 of the suture anchor 100 is the driving end 50. As illustrated in Figure 1, for example, the driving end 50 has a distal end 51 and a proximal end 53. The driving end 50 is provided with two transverse suture passages 80, 81, preferably both substantially perpendicular to longitudinal axis 11 of the elongated body member 10. The first transverse mounting suture passage 80 is seen in Figure 1 to extend through the distal end 51 of the driving end 50 and to have opposed openings 80a, 80b. The second transverse mounting suture passage 81 is located proximal to the first suture passage 80, and is also provided with two opposed openings 81a, 81b. The second transverse mounting suture passage 81 is also preferably substantially perpendicular to the longitudinal axis 11 of the elongated body member 10, but may also be angulated if desired.

[0018] As also shown in Figure 1, four grooves 82 are provided on either side of the driving end 50 and extend proximally from each of the openings of the transverse suture passages 80, 81. Grooves 82 accept and protect suture filament 60 as it passes along the sides of the driving end 50 of the suture anchor 100. As also illustrated in Figure 1, cruciform drive socket 57 is formed in the proximal end 53 of the driving end 50. Preferably, the cruciform drive socket 57 is tapered inward distally and is provided to a depth that allows sufficient strength while not intersecting with suture passages 80, 81.

[0019] As further illustrated in Figure 1, disk 70 is provided with cruciform driver opening 77 located centrally on the disk 70 and aligns with cruciform drive socket 57 of the driving end 50. Disk 70 is also provided with a pair of holes 76 through which a single suture strand 60 passes for capturing disk 70. As shown in Figure 2, the ends of suture strand 60 are tied in a single knot 88 and the knot 88 is housed into a recess within one of the transverse suture passages 80, 81, rather than on top surface 73 of the disk 70. Alternatively, the ends of the suture strand 60 can terminate in the anchor separately, without being tied together in a single knot. In this latter embodiment, two separate knots are formed and housed within two separate suture passages or, alternatively, within a single suture passage.

[0020] Figure 3 illustrates another embodiment of the present invention, in which a single suture strand 260 passes around the exterior of the disk 270 and through the holes 276. As in the previously-described embodiment, the filament 260 is tied in a single knot which is secured within eyelet 280 of the suture anchor 200, rather than on the upper surface of disk 270.

[0021] The suture anchor of the present invention may be typically employed in arthroscopic surgical procedures to repair a rotator cuff, for example, but may be also used in open surgical procedures. The suture anchor of the present invention has the advantage that it eliminates knotting on the upper surface of

the tissue-fixation device improving the efficiency of attachment of soft tissue to bone in a surgical procedure.

[0022] For example, Figure 4 illustrates the suture anchor assembly 100 (Figures 1-2) according to the first embodiment of the present invention loaded on a driver 90 of the present invention, while Figure 5 illustrates the suture anchor assembly 100 (Figures 1-2) installed in the body at a repair site so as to approximate soft tissue to bone. As shown in Figure 4, driver 90 of the present invention has a cannulated handle 92 coupled to a cannulated driver shaft 94. The distal tip 95 of the driver 90 is shaped to matingly engage and complement both the cruciform drive socket 57 of the suture anchor 100 and the central opening 77 formed in the disk 70. Accordingly, driver 90 rotationally engages both the suture anchor 100 and the disk 70, such that the disk and the suture anchor turn simultaneously with the driver, avoiding tension on suture strand 60. Accordingly, no twisting or abrading of the suture strand 60 which captures the disk 70 occurs during insertion of the fixation device into bone.

[0023] As also shown in Figure 4, cannulated driver 90 is provided with openings near the distal end which accept traction line 36. Traction line 36 is looped through holes 33 formed in disk 70, as illustrated in Figure 4, and is passed through the cannulated driver 90. Tension on traction line 36 applied proximally holds the fixation device to the driver tip, the traction suture having been retained in notches 38 formed on proximal end of cannulated handle 92. Traction line 36 can also be used to confirm fixation strength after installation. Additionally, traction line 36 can be used to retrieve the disk 70 or the entire fixation device in the event of device failure during installation. Once the installation and fixation strength are determined to be adequate, traction line 36 easily is removed by pulling on one end of the traction line.

[0024] The driver 90 (Figure 4) with the engaged suture anchor 100 of the present invention may be employed for installing the suture anchor in the body during an arthroscopic surgical procedure, such as rotator cuff repair. For

example, Figure 5 illustrates the suture anchor assembly 100 (Figures 1-2) installed in the body at a repair site so as to approximate soft tissue to bone, and after the removal of the driver 90 from the repair site. As illustrated diagrammatically in side elevation in Figure 5, the suture anchor assembly 100 includes disk 70 which is provided with pair of holes 76 through which the single suture strand 60 passes for capturing disk 70. As shown in Figure 5, the ends of suture strand 60 are tied in single knot 88 and the knot 88 is housed within one of the two suture passages 80, 81, rather than on top surface 73 of the disk 70.

[0025] The elongated body member 10 of the anchor 100, 200 of the present invention may be constructed from a conventional implantable bio-compatible materials, such as titanium. The disk 70, 270 and suture strand 60, 260 may be manufactured from conventional biocompatible polymeric materials and may be absorbable or non-absorbable. A high strength suture sold by Arthrex, Inc., the assignee of the present application, under the tradename FiberWire and described in allowed U.S. Serial No. 09/950,598, the disclosure of which is hereby incorporated herein by reference, may also be employed in the present invention.

[0026] Although the present invention has been described above with reference to a suture anchor having four grooves on the sides of the driving end, such as the suture anchor 100, 200 having four grooves 82 on the sides of the driving end 50, it must be understood that this embodiment is only illustrative and the invention is not limited to it. Accordingly, the present invention also contemplates a suture anchor having any plurality of grooves on the sides of the driving end, as long as the ends of the suture strand are tied in a knot which is housed within a recess of the driving end, and not on top of the tissue-fixation disk.

[0027] In addition, although the present invention has been described above with reference to a tissue-fixation device in the form of a disk, such as the tissue-fixation disk 70, 270, the invention also contemplates alternative embodiments

accomplished with various types of tissue fixation means substituted for disk 70, 270, such as a ring, cross, straight bar, or bended bar, among others. In addition, various types of suture anchors, for example a smooth spike, barbed spike, cylindrical threaded anchor, or expanding anchor, can be used to anchor the assembly of the present invention.

[0028] The above description and drawings illustrate preferred embodiments which achieve the objects, features and advantages of the present invention. It is not intended that the present invention be limited to the illustrated embodiments. Any modification of the present invention which comes within the spirit and scope of the following claims should be considered part of the present invention.